Chukchi Sea Play 21: Upper Brookian Paleovalleys

Geological Assessment

GRASP UAI: AAAAA DAV
Play Area: 7,252 square miles
Play Water Depth Range: 115-180 feet
Play Depth Range: 2,472-12,000 feet
Play Exploration Chance: 0.11875

Play 21, Upper Brookian Paleo-Valleys, Chukchi Sea OCS Planning Area, 2006 Assessment, Undiscovered Technically-Recoverable Oil & Gas

Assessment Results as of November 2005

Resource Commodity (Units)	Resources *		
	F95	Mean	F05
BOE (Mmboe)	0	1,612	5,532
Total Gas (Tcfg)	0.000	3.386	11.146
Total Liquids (Mmbo)	0	1,010	3,548
Free Gas** (Tcfg)	0.000	2.558	8.220
Solution Gas (Tcfg)	0.000	0.827	2.926
Oil (Mmbo)	0	871	3,114
Condensate (Mmbc)	0	139	435

** Risked, Technically-Recoverable*

*** Free Gas Includes Gas Cap and Non-Associated Gas*

F95 = 95% chance that resources will equal or exceed the given quantity

F05 = 5% chance that resources will equal or exceed the given quantity

BOE = total hydrocarbon energy, expressed in barrels-of-oil-equivalent, where 1 barrel of oil = 5,620 cubic feet of natural gas

Mmb = millions of barrels

Tcf = trillions of cubic feet

Table 1

Play 21, the "Upper Brookian Paleovalleys" play, is the fifth most important play (of 29 plays) in the Chukchi Sea OCS Planning Area, with 5.6% (1,612 Mmboe) of the Planning Area energy endowment (29,041 Mmboe). The overall assessment results for play 21 are shown in table 1. Oil and gas-condensate liquids form 63% of the hydrocarbon energy endowment of play 21.

Table 5 reports the detailed assessment results by commodity for play 21.

Table 3 summarizes the volumetric input data developed for the *GRASP* computer model of Chukchi play 21. Table 4 reports the risk model used for play 21. The location of play 21 is shown in figure 1.

Potential reservoirs are primarily fluvial sandstones deposited in paleovalleys (developed over grabens bounded by transtensional faults) that emptied northward from Chukchi platform into North Chukchi basin in Paleocene time. The fluvial sandstones lie at the base of a transgressive Paleocene sequence that records progressive drowning of the valleys. This play was penetrated at Popcorn, Crackerjack, and Klondike wells. All wells encountered highly porous sandstones at the base of Paleocene rocks, with the maximum observed sandstone thickness reaching 540 feet at Popcorn well. Traps are primarily stratigraphic pinch-outs or fault truncations of the fluvial sandstones along the north-trending valley margins. Minor diapir-flank traps occur in a narrow graben west of Popcorn well. The play is modeled as predominantly charged by the Hanna trough play charging system, although some parts of the play extend north into North Chukchi basin and may be charged by hydrocarbons migrating from that area. No shows or zones of pooled oil or gas were encountered in Upper Brookian sandstones in any of the three wells that penetrated the sequence.

Play 21, Upper Brookian Paleo-Valleys, Chukchi Sea OCS Planning Area, 2006 Assessment, Conditional BOE Sizes of Ten Largest Pools			
Assessment Results as of November 2005			
Pool Rank	BOE Resources *		
	F95	Mean	F05
1	311	1075	2766
2	187	571	1140
3	123	396	811
4	83	296	600
5	58	231	476
6	42	185	390
7	32	152	328
8	26	127	281
9	22	109	244
10	18	94	214

** Conditional, Technically-Recoverable, Millions of Barrels Energy-Equivalent (Mmboe), from "PSRK.out" file*

F95 = 95% chance that resources will equal or exceed the given quantity

F05 = 5% chance that resources will equal or exceed the given quantity

BOE = total hydrocarbon energy, expressed in barrels-of-oil-equivalent, where 1 barrel of oil = 5,620 cubic feet of natural gas

Table 2

A maximum of 47 hypothetical pools is forecast by the aggregation of the risk model and the prospect numbers model for play 21. These 47 pools range in mean conditional (un-risked) recoverable volumes from 13 Mmboe (pool rank 47) to 1,075 Mmboe (pool rank 1). Pool rank 1 ranges in possible conditional recoverable volumes from 311 Mmboe (F95) to 2,766 Mmboe (F05). Table 2 shows the conditional sizes of the 10 largest pools in play 21.

In the computer simulation for play 21 a total of 59,275 “simulation pools” were sampled for size. These simulation pools can be grouped according to the USGS size class system in which sizes double with each successive class. Pool size class 13 contains the largest share (14,063, or 24%) of simulation pools (conditional, technically recoverable BOE resources) for play 21.

Pool size class 13 ranges from 128 to 256 Mmboe. The largest 33 simulation pools for play 21 fall within pool size class 18, which ranges in size from 4,096 to 8,192 Mmboe. Table 6 reports statistics for the simulation pools developed in the GRASP computer model for play 21.

GRASP Play Data Form (Minerals Management Service-Alaska Regional Office)

Basin: Chukchi Sea Planning Area
Play Number: 21
Play UAI Number: AAAAA DAV

Assessor: K.W. Sherwood
Play Name: Upper Brookian - Paleovalleys

Date: January 2005

Play Area: mi² (million acres) 7,252 (4.641)
Reservoir Thermal Maturity: % Ro 0.35 - 0.92

Play Depth Range: feet 2,472 - 12,000 (mean = 5,421)
Expected Oil Gravity: ° API 30
Play Water Depth Range: feet 115 - 180 (mean = 150)

POOLS Module (Volumes of Pools, Acre-Feet)

Fractile	F100	F95	F90	F75	F50	Mean/Std. Dev.	F25	F15	F10	F05	F02	F01	F00
Prospect Area (acres)-Model Input*	419		1444		5059	8163/10335			17720				43026
Prospect Area (acres)-Model Output**	421	1070	1490	2622	4951	7347/7066	9484	13163	16704	22433			42964
Fill Fraction (Fraction of Area Filled)	0.18	0.30	0.32	0.37	0.43	0.44/0.10	0.50	0.54	0.57	0.62			1.00
Productive Area of Pool (acres)***	147	429	615	1094	2097	3219/3256	4128	5861	7331	9893	13000	14000	28142
Pay Thickness (feet)	40	114	132	168	220	238/99	288	333	367	425	500	558	700

* model fit to prospect area data in *BESTFIT*
** output from *@RISK* after aggregation with fill fraction
*** from *@RISK* aggregation of probability distributions for prospect area and fill fraction

MPRO Module (Numbers of Pools)

Input Play Level Chance	0.5
Output Play Level Chance*	0.4997

Prospect Level Chance	0.2375

Exploration Chance	0.11875

* First Occurrence of Non Zero Pools As Reported in PSUM Module

Risk Model	Play Chance	Petroleum System Factors	Prospect Chance
	0.8	Trap Integrity (numerous faults, many traps are down-side fault traps)	0.5
	0.625	Seal Presence (very sandy section)	
		Chance Porosity > 10%	0.95
		Migration (risk of migrating hydrocarbons being diverted up numerous shallow, young faults)	0.5

Fractile	F99	F95	F90	F75	F50	Mean/Std. Dev.	F25	F15	F10	F05	F02	F01	F00
Numbers of Prospects in Play	27	30	33	40	48	49.88/13.75	57	63	66	69	80	89	135
Numbers of Pools in Play						5.92/6.70	11	14	15	17	20	22	47

Zero Pools at F50.00

Minimum Number of Pools	7 (F45)	Mean Number of Pools	5.92	Maximum Number of Pools	47

POOLS/PSRK/PSUM Modules (Play Resources)

Fractile	F100	F95	F90	F75	F50	Mean/Std. Dev.	F25	F15	F10	F05	F02	F01	F00
Oil Recovery Factor (bbl/acre-foot)	78	134	157	205	275	300/134	365	427	479	553	620	690	1184
Gas Recovery Factor (Mcfg/acre-foot)	320	686	809	1023	1365	1468/608	1793	2061	2267	2606	3000	3200	5599
Gas Oil Ratio (Sol'n Gas)(cf/bbl)	200	650	720	830	960	951/210	1080	1150	1200	1270	1350	1400	1700
Condensate Yield ((bbl/Mmcfg)	13	29	33	40	50	54/19	64	72	79	90	105	120	200

Pool Size Distribution Statistics from *POOLS* (1,000 BOE): μ (mu)= 11.924 σ² (sigma squared)= 1.253
Random Number Generator Seed= 000070

BOE Conversion Factor (cf/bbl)	5620
Probability Any Pool is 100% Oil	0.2
Probability Any Pool is 100% Gas	0.2

Probability Any Pool Contains Both Oil and Free Gas (Gas Cap)	0.6
Fraction of Pool Volume Gas-Bearing in Oil Pools with Gas Cap	0.3

Table 3. Input data for Chukchi Sea play 21, 2006 assessment.

Risk Analysis Form - 2006 National Assessment

Assessment Province:	Chukchi Sea OCS Planning Area	**Play Number, Name:**	21. Upper Brookian Paleo-Valleys
Assessor(s):	K.W. Sherwood	**Play UAI:**	AAAAA DAV
Date:	1-Jan-05		

For each component, a *quantitative* probability of success (i.e., between zero and one, where zero indicates no confidence and one indicates absolute certainty) based on consideration of the *qualitative* assessment of **ALL** elements within the component was assigned. This is the assessment of the probability that the minimum geologic parameter assumptions have been met or exceeded.

			Play Chance Factors	Averge Conditional Prospect Chance[1]
1.	**Hydrocarbon Fill component** (1a * 1b * 1c)	**1**	***1.0000***	***0.5000***
	a. Presence of a Quality, Effective, Mature Source Rock			
	Probability of efficient source rock in terms of the existence of sufficient volume of mature source rock of adequate quality located in the drainage area of the reservoirs.	1a	1.00	1.00
	b. Effective Expulsion and Migration			
	Probability of effective expulsion and migration of hydrocarbons from the source rock to the reservoirs.	1b	1.00	0.50
	c. Preservation			
	Probability of effective retention of hydrocarbons in the prospects after accumulation.	1c	1.00	1.00
2.	**Reservoir component** (2a * 2b)	**2**	***1.0000***	***0.9500***
	a. Presence of reservoir facies			
	Probability of presence of reservoir facies with a minimum net thickness and net/gross ratio (as specified in the resource assessment).	2a	1.00	1.00
	b. Reservoir quality			
	Probability of effectiveness of the reservoir, with respect to minimum effective porosity, and permeability (as specified in the resource assessment).	2b	1.00	0.95
3.	**Trap component** (3a * 3b)	**3**	***0.5000***	***0.5000***
	a. Presence of trap			
	Probability of presence of the trap with a minimum rock volume (as specified in the resource assessment).	3a	1.00	0.50
	b. Effective seal mechanism			
	Probability of effective seal mechanism for the trap.	3b	0.50	1.00
	Overall Play Chance (Marginal Probability of hydrocarbons, MPhc)		***0.5000***	
	(1 * 2 * 3) *Product of All Subjective Play Chance Factors*			
	Average Conditional Prospect Chance[1]			***0.2375***
	(1 * 2 * 3) *Product of All Subjective Conditional Prospect Chance Factors*			
	[1] Assumes that the Play exists (where all play chance factors = 1.0)			
	Must be consistent with play chance and prospect distribution -- See discussion on Page 3 of Guide			
	Exploration Chance		***0.1188***	
	(Product of Overall Play Chance and Average Conditional Prospect Chance)			

Comments: *See guidance document for explanation of the Risk Analysis Form*

2b: Chance That Porosity >10%, Based on Regional Model for Porosity vs Reservoir Thermal Maturity

Table 4. Risk model for Chukchi Sea play 21, 2006 assessment.

GRASP - Geologic and Economic Resource Assessment Model - PSUM Module Results

Minerals Management Service - Alaska OCS Region

GRASP Model Version: 8.29.2005)

Computes the Geologic Resource Potential of the Play

Play UAI:	**AAAAADAV**		**Play No.**		**21**		
World	Level	-	World	Level		Resources	
Country	Level	-	UNITED	STATES		OF	AMERICA
Region	Level	-	MMS	-		ALASKA	REGION
Basin	Level	-	**CHUKCHI**	**SEA**		**SHELF**	
Play	**Level**	**-**	**Play**		**21**	**Upper Brookian Paleovalleys**	
Geologist	Kirk	W.	Sherwood				
Remarks	2005	Assessment					
Run Date & Time:		Date	19-Sep-05	Time		13:56:23	

Summary of Play Potential

Product	MEAN	Standard Deviation
BOE (Mboe)	1,612,200	2,043,800
Oil (Mbo)	871,270	1,158,200
Condensate (Mbc)	138,570	200,460
Free (Gas Cap & Nonassociated) Gas (Mmcfg)	2,558,400	3,581,600
Solution Gas (Mmcfg)	827,180	1,107,800

10000 (Number of Trials in Sample)

0.4997 (MPhc [Probability] of First Occurrence of Non-Zero Resource)

Windowing Feature: used

Empirical Probability Distributions of the Products

Greater Than Percentage	BOE (Mboe)	Oil (Mbo)	Condensate (Mbc)	Free (Gas Cap & Nonassociated) Gas (Mmcfg)	Solution Gas (Mmcfg)
100	0	0	0	0	0
99.99	0	0	0	0	0
99	0	0	0	0	0
95	0	0	0	0	0
90	0	0	0	0	0
85	0	0	0	0	0
80	0	0	0	0	0
75	0	0	0	0	0
70	0	0	0	0	0
65	0	0	0	0	0
60	0	0	0	0	0
55	0	0	0	0	0
50	166,460	85,035	14,911	292,370	81,451
45	1,265,100	626,950	123,530	2,295,400	596,770
40	1,752,300	924,150	153,480	2,906,400	885,050
35	2,143,100	1,170,400	176,270	3,377,700	1,098,600
30	2,533,900	1,349,100	217,610	4,148,400	1,286,900
25	2,921,100	1,557,600	260,960	4,706,800	1,489,200
20	3,352,700	1,711,500	311,630	5,845,700	1,626,500
15	3,823,000	2,041,600	340,010	6,145,300	1,955,000
10	4,520,700	2,451,600	388,710	7,091,600	2,352,100
8	4,841,800	2,753,600	368,600	7,026,400	2,637,600
6	5,257,000	2,812,200	458,560	8,474,000	2,688,700
5	5,531,700	3,113,500	434,880	8,220,100	2,926,300
4	5,840,500	3,193,000	506,860	9,000,400	3,030,300
2	6,908,500	3,861,600	564,610	10,288,000	3,662,300
1	7,925,900	4,401,400	643,110	11,968,000	4,225,200
0.1	10,493,000	5,584,800	795,640	17,526,000	5,585,600
0.01	15,695,000	9,882,000	949,720	18,829,000	8,501,700
0.001	20,150,000	9,175,100	2,501,300	39,539,000	8,083,400

Table 5. Assessment results by commodity for Chukchi Sea play 21, 2006 assessment.

Basin: CHUKCHI SEA SHELF
Play 21 - U. Brookian - Tertiary Fluvial Valleys
UAI Key: AAAAADAV

Model Simulation "Pools" Reported by "Fieldsize.out" *GRASP* Module

Classification and Size				Pool Count Statistics				Pool Types Count			Mixed Pool Range		Oil Pool Range		Gas Pool Range		Total Pool Range			Pool Resource Statistics (MMBOE)			
Class	Min (MMBOE)	Max (MMBOE)	Pool Count	Percentage	Trial Average	Trials w/Pool Avg		Mixed Pool	Oil Pool	Gas Pool	Min	Max	Min	Max	Min	Max	Min	Max		Min	Max	Total Resource	Average Resource
1	0.0312	0.0625	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0		0.000000	0.000000	0.000000	0.000000
2	0.0625	0.125	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0		0.000000	0.000000	0.000000	0.000000
3	0.125	0.25	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0		0.000000	0.000000	0.000000	0.000000
4	0.25	0.5	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0		0.000000	0.000000	0.000000	0.000000
5	0.5	1	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0		0.000000	0.000000	0.000000	0.000000
6	1	2	1	0.001687	0.0001	0.0002		0	1	0	0	0	1	1	0	0	1	1		1.167483	1.167483	1.167483	1.167483
7	2	4	29	0.048925	0.0029	0.005802		10	10	9	1	1	1	1	1	1	1	2		2.405221	3.970130	98.032870	3.380444
8	4	8	275	0.463939	0.0275	0.055022		134	62	79	1	1	1	1	1	2	1	2		4.000993	7.993069	1767.046000	6.425621
9	8	16	1287	2.171236	0.1287	0.257503		730	272	285	1	3	1	3	1	2	1	4		8.030662	15.998662	15855.540000	12.319767
10	16	32	3601	6.075074	0.3601	0.720488		2093	726	782	1	4	1	3	1	3	1	6		16.000552	31.983997	87377.244000	24.264717
11	32	64	7988	13.476171	0.7988	1.598239		4709	1636	1643	1	6	1	4	1	4	1	9		32.002837	63.999521	379936.172000	47.563366
12	64	128	12565	21.197807	1.2565	2.514006		7495	2443	2627	1	10	1	5	1	6	1	15		64.006366	127.930583	1174110.000000	93.442886
13	128	256	14063	23.72501	1.4063	2.813725		8553	2811	2699	1	9	1	6	1	5	1	14		128.002229	255.930915	2583813.000000	183.731293
14	256	512	11235	18.954027	1.1235	2.247899		6925	2245	2065	1	7	1	5	1	4	1	11		256.022893	511.942237	4064565.000000	361.777069
15	512	1024	6021	10.15774	0.6021	1.204682		3708	1129	1184	1	7	1	4	1	4	1	11		512.095245	1023.990000	4239206.000000	704.070007
16	1024	2048	1821	3.072121	0.1821	0.364346		1099	368	354	1	3	1	3	1	2	1	4		1024.239000	2042.739000	2466269.000000	1.354349
17	2048	4096	356	0.60059	0.0356	0.071228		202	95	59	1	2	1	2	1	2	1	2		2051.513000	4067.732000	936546.517000	2.630749
18	4096	8192	33	0.055673	0.0033	0.006603		19	11	3	1	1	1	1	1	1	1	2		4173.906000	7561.393000	172951.566000	5.240957
19	8192	16384	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0		0.000000	0.000000	0.000000	0.000000
20	16384	32768	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0		0.000000	0.000000	0.000000	0.000000
21	32768	65536	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0		0.000000	0.000000	0.000000	0.000000
22	65536	131072	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0		0.000000	0.000000	0.000000	0.000000
23	131072	262144	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0		0.000000	0.000000	0.000000	0.000000
24	262144	524288	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0		0.000000	0.000000	0.000000	0.000000
25	524288	1048576	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0		0.000000	0.000000	0.000000	0.000000
Not Classified			0	0	0	0	Below Class	0	0	0									Below Class	0.000000	0.000000	0.000000	0.000000
		Totals	**59275**	**100**	**5.9275**	**11.859742**	Above Class	0	0	0									Above Class	0.000000	0.000000	0.000000	0.000000

Number of Pools not Classified: 0
Number of Pools below Class 1: 0
Number of Trials with Pools: 4998

Min and Max refer to numbers of pools of the relevant size class that occur within any single trial in the simulation.

Min and Max refer to aggregate resources of the relevant size class that occur within any single trial in the simulation.

Table 6. Statistics for simulation pools created in computer sampling run for Chukchi Sea play 21, 2006 assessment.

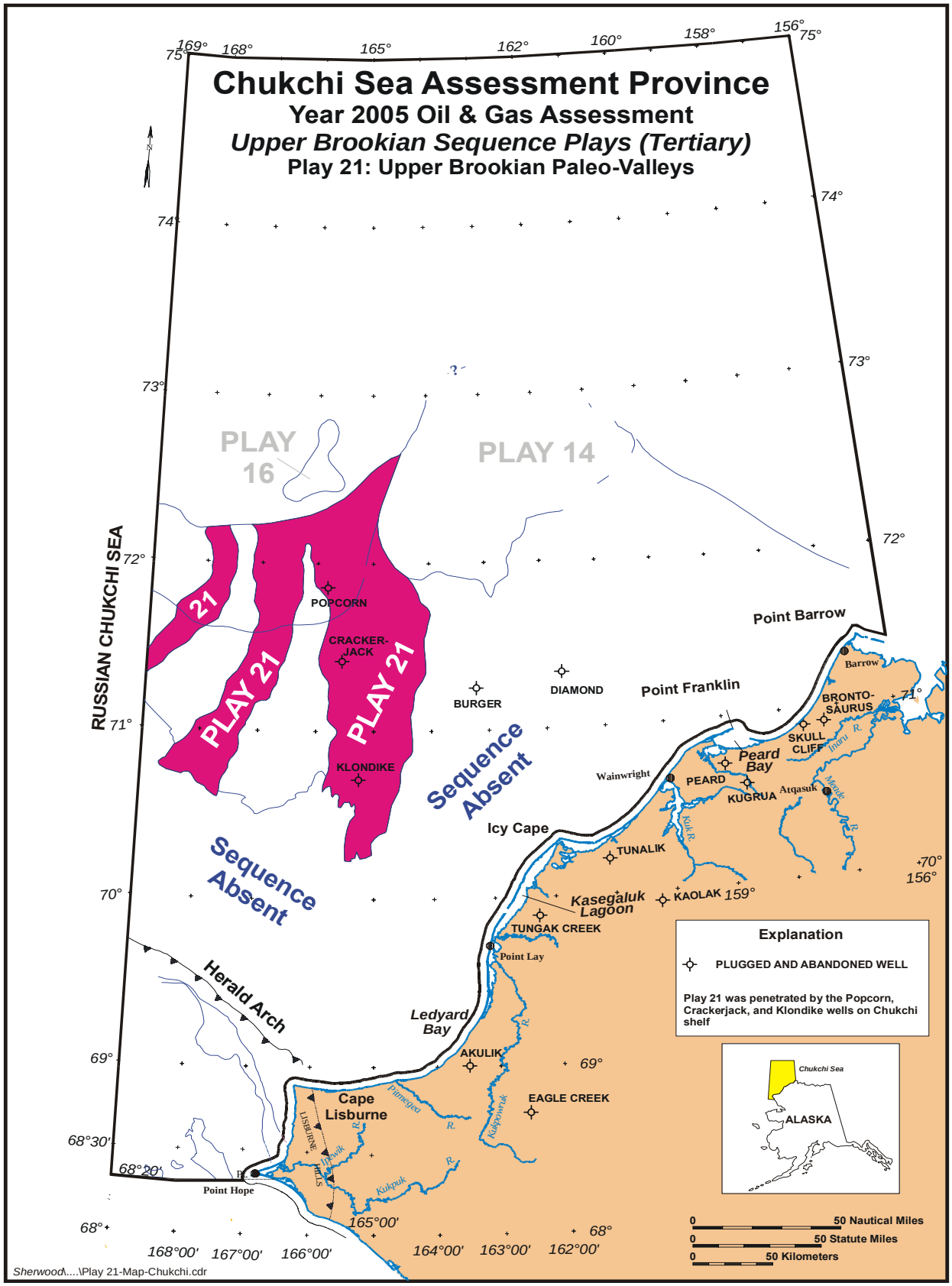

Figure 1. Map location of Chukchi Sea play 21, 2006 assessment.